AZBEL, M. YA.

USSR/Physics - Film conductivity

Card 1/1 Pub. 22 - 8/45

Authors : Azbel', M. Ya.

Title : Film conductivities in a longitudinal magnetic field

Periodical : Dok. AN SSSR 99/4, 519-522, Dec 1, 1954

Abstract : An analytical expression for the effective conductivity of metal films in a constant longitudindal magnetic field (H) is sought. By imposing certain conditions upon the magnetic field and the electron behavior in such a field, the following sought expression is found: $\sigma = \int_0^d jdz \vert Ed$, and its theoretical and physical meanings are analyzed. Three references (1938-1953). Diagrams; graph.

Institution : Kharkov State University im. A. M. Gorkiy

Presented by: Academician L. D. Lindau, September 20, 1954

AZBEL', M. YA.

AZBEL', M. YA. -- "Kinetic Theory of the Conductivity of Metals." *(Dissertations for Degrees in Science and Engineering Defended at USSR Higher Educational Institutions) Min Higher Education Ukrainian SSR, Khar'kov Order of Labor Red Banner State U imeni A. M. Gor'kiy, Khar'kov, 1955.

SO: Knizhnaya Letopis' No. 31, 30 July 1955

*For the Degree of Candidate in Physicomathematical Sciences.

USSR/Physics - Superconductors Azbel, M. Ya FD-3353

Card 1/1 Pub. 146-25/28

Author : Azbel M. Ya.

Title : Determination of dielectric constant of superconductors

Periodical : Zhur. Eksp. i Teor. Fiz., 29, No 5, 705-707, 1955

Abstract : Experimental results obtained by A. A. Galkin (DAN Ukrainian SSR, No 6, 1952) on the dielectric constant of superconductors may be comprehended, if the anisotropy of superconductors is taken under consideration. The introduction of anisotropy into equations substantially changes the expression of surface impedance of superconductors. Indebted to I. M. Lifshits for discussions. Four references.

Institution : --

Submitted : July 14, 1955

Azbel', M. Ya.

USSR/Physics - Skin effect FD-3265

Card 1/1 Pub. 146-24/44

Author : Azbel', M. Ya.; Kaner E. A.

Title : Anomalous skin effect for arbitrary integral of collisions

Periodical : Zhur. eksp. i teor. fiz., 29, No 6(12), Dec 1955, 876-878

Abstract : In an earlier work (M. I. Kaganov, M. Ya. Azbel', DAN SSSR, 102, 49, 1955) one of the authors obtained an expression for the surface impedance of a metal in the case of anomalous skin effect (i. e. an effect taking place at high frequencies and low temperatures, when the length of free path of electrons is large in comparison with the depth of penetration of the field into the metal); here it was assumed that the integral of collisions can be written with the aid of the relaxation time tau, distribution function of electrons, and equilibrium Fermi distribution function. Introduction of the relaxation time can be strictly founded only for high temperatures (i. e. much greater than the Debye temperature); for lower temperatures the integral of collisions generally cannot be described in the usual form. In the present communication the authors demonstrate that the formula for impedance obtained in the above mentioned work is correct for arbitrary integral of collisions, use being made of the central symmetry of the Fermi surface. They thank I. M. Lifshits for judging the obtained results. Two references.

Submitted : July 14, 1955

AZBEL, M. YA.

Category : USSR/Electricity - Conductors

G-4

Abs Jour : Ref Zhur - Fizika, No 1, 1957 No 1621

Author : Azbel', M.Ya., Kaganov, M.I.

Title : On the Theory of the Anomalous Skin Effect in Thin Films

Orig Pub : Uch. zap. Khar'kovsk. un-ta., 1955, 64, 59-65

Abstract : The authors consider the normal incidence of a plane monochromatic wave on a thin metallic film, the thickness of which is much less than the free path l. The behavior of the conduction electrons is described by the kinetic equation for the distribution function of the electrons in phase space. An expression is derived for the surface impedance of metal films in the normal and in the superconducting states. The dependence of the surface impedance on the film thickness d and on the frequency ω is investigated. The ratio of the active component R to the inducted component X for superconducting films is approximately equal to ω; for films made of metal in the normal state $R/X \sim 1/\omega$ (at low temperatures). In the case of superconducting films, the value of X depends little on d outside of the dependence on the behavior of the electrons at the metal boundary; in this case $R \sim 1/d$ in the case of mirror reflection of the electrons from the boundary, and $R \sim \ln d/l$ in the case of diffuse reflection.

Card : 1/1

AZBEL', M. Ya.

USSR/ Physics - Skin effect

Card 1/1 Pub. 22 - 9/54

Authors : Azbel', M. Ya.

Title : Regarding the theory of skin effect in a constant magnetic field

Periodical : Dok. AN SSSR 100/3, 437-440, Jan. 21, 1955

Abstract : The surface impedance of a metal in a constant magnetic field parallel to to the metal surface is sought. The electron reflection from the metal surface is considered as a diffusive process. Mathematical expressions are derived for two cases of skin effect: (1) for low frequencies; and (2) for high frequencies. All quantities are taken at the border of the Fermi distribution. Five references: 3 USSR and 2 English (1949-1954).

Institution: ....

Presented by: Academician L. D. Landau, June 18, 1954

L 37693-65 EWT(d) Pg-4 IJP(c)

ACCESSION NR: AP5000903 S/0020/64/159/004/0703/0706

AUTHOR: Azbel', M. Ya.

TITLE: On the Spectrum of Difference Equations with Periodic Coefficients

SOURCE: AN SSSR. Doklady, v. 159, no. 4, 1964, 703-706

TOPIC TAGS: Difference equation, spectrum, differential equation, numerical method, mathematical physics, Shrödinger equation, quasiparticle

ABSTRACT: The author considers the equations of the type

$$Ly(x) \equiv \sum_{n=-l}^{l} f_n(x)\, y(x + 2\pi n\beta) = \lambda y(x),$$
$$f_n(x + 2\pi) = f_n(x); \quad f_n(x) = \overline{f_n(x - 2\pi n\beta)}, \qquad (1)$$

where it is assumed, without loss of generality, that $1 \leq \beta < 1$. (This equation corresponds to the Shrödinger equation for charged quasiparticles with period dispersion laws in a constant magnetic field ...

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Card 2/2

AZBEL', M. YA.

USSR/ Physics - Skin effect

Card 1/2 Pub. 22 - 12/49

Authors : Kaganov, M. I., and Azbel', M. Ya.

Title : Regarding the theory of the anomalous skin effect

Periodical : Dok. AN SSSR 102/1, 49-51, May 1, 1955

Abstract : An exact expression of the anomalous skin effect is sought. It is, basically, a further development of Pippard's theory on the same subject. Pippard, under the assumption that surface electrons are governed by the law of an optional dispersion, obtained an approximate expression for the skin effect. The authors, under the same assumption, obtained the

Institution : The Acad. of Sce., Ukr. SSR, Physico-Technical Institute

Presented by : Academician L. D. Landau, February 1, 1955

Card 2/2 Pub. 22 - 12/49

Periodical : Dok. AN SSSR 102/1, 49-51, May 1, 1955

Abstract : following formulas for the skin effect, $Z_{x,y}$:

$$Z_{x,y} = \begin{cases} \left(\sqrt{3}\pi \dfrac{\omega^2}{c^4 B_{x,y}}\right)^{1/3} (1 + \sqrt{3}i)^* & (q = 0); \\ \dfrac{8}{9}\left(\sqrt{3}\pi \dfrac{\omega^2}{c^4 B_{x,y}}\right)^{1/3} (1 + \sqrt{3}i) & (q = 1) \end{cases}$$

The symbols c , B and ω are explained. Six references: 1 USSR, 1 Germ., and 4 Brit. (1938-1954).

AZBEL, M. Ya, LIFSHITS, I. M. and KAGANOV, M. I. (Khar'kov)

"On the Theory of Galvanomagnetic Phenomena," paper presented at the International Conference on Physics of Magnetic Phenomena, Sverdlovsk, USSR, 23-31 May 1956.

AZBEL, M. YA.

L 3004 9 0.1 3

PARAMAGNETIC RESONANCE AND POLARIZATION OF NUCLEI IN METALS. I. M. Lifshits, M. Ya. Azbel', and V. I. Gerasimenko (Physico-Technical Inst., Academy of Science of the Ukrainian S.S.R., Kharkov). Phys. and Chem. of Solids 1, 194-7[illegible](1956) Nov.

A theory of paramagnetic resonance in metals is constructed, based on a simultaneous solution of Maxwell's equations and of the kinetic equation for the density operator. The polarization of the nuclei in the metal is determined. It is shown that this polarization always varies slowly with depth, diminishing as $\exp(-z/\Delta_{\parallel})$, where $\Delta_{\parallel} \sim v\sqrt{T_2 T_1} \sim 10^{-3}$ to 1 cm is the mean distance travelled by an electron between collisions in which its spin is reversed. It is found that in paramagnetic resonance there is a selective transparency of metallic films, and the transmitted wave is circularly polarized, if the constant magnetic field is normal to the surface. (auth)

AZBEL', M. Ya.

537.312.8 3/4

6558 ON THE THEORY OF GALVANOMAGNETIC PHENOMENA IN METALS. I.M.Lifshits, M.Ya.Azbel' and M.I.Kaganov.
Zh. eksper. teor. Fiz., Vol. 30, No. 1, 220-2 (1956). In Russian.

Phys

It is shown that in the limit of very strong magnetic field strengths some elements of the conductivity tensor are independent of the scattering mechanism, and that in some cases it is possible in principle to deduce the topology of the Fermi surface from experimental data. J.M.Radcliffe

Azbel', M. Ya.

Category : USSR/Electricity - Conductors G-4

Abs Jour : Ref Zhur - Fizika, No 2, 1957, No 4242

Author : Azbel', M. Ya., Kaner, E. A.
Inst : Physicotechnical Institute, Academy of Sciences Ukrainian SSR, Khar'kov
Title : Theory of Cyclotron Resonance in Metals

Orig Pub : Zh. eksperim. i teor. fiziki, 1956, 30, No 4, 811-814

Abstract : An investigation of the surface impedance of a metal as a function of the value of a constant magnetic field applied parallel to its surface, for arbitrary dispersion and for an arbitrary collision integral. Since the resonance impedance dip occurs at such frequencies, at which the anomalous skin effect takes place, the authors solve simultaneously Maxwell's equation and the kinetic equation in addition to the Fermi distribution function. Unlike the known "diamagnetic" resonance (using the author's terminology), which occurs in semiconductors at a single frequency, cyclotron resonance occurs in metals at many frequencies, close to multiples of the fundamental frequency. Experimental study of cyclotron resonance makes it possible in principle to determine the

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AZBEL, M. YA.

regarding the law of conservation, of ... dispersion or the form of the collision integral are made.

1. Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR.

(Magnetic fields) (Electrons) (Metals)

AZBEL', M.YA.

SUBJECT USSR / PHYSICS CARD 1 / 2 PA - 1488

AUTHOR AZBEL',M.JA., GERASIMENKO,V.I., LIFSIČ,I.M.

TITLE The Paramagnetic Resonance and the Polarization of Nuclei in Thick Layers of Metal.

PERIODICAL Žurn.eksp.i teor.fis,31, fasc.2, 357-359 (1956)
Issued: 10 / 1956 reviewed: 11 / 1956

It is shown that with the help of a high frequency magnetic field $H_1 \widetilde{\gg} (8\pi\delta_{eff}/c^2\, Z\, T_{fw})H_0$ it is possible to polarize nuclei of rather great depth: $\delta_{eff} \sim 10^{-2}$ up to 1 cm (up to which the electron progresses on the occasion of diffusion during the time T_{fw}). Here H_0 and H_1 denote the field strengths of the constant and high frequency magnetic field, T_{fw} - the time of the free length of path of an electron with spin exchange (?), Z - the surface impedance of the metal. For the development of a consequent theory the following MAXWELL'S equations: curl $\vec{E} = -(1/c)\partial\vec{B}/\partial t$, curl $H_1 = (4\pi/c)\vec{j}$, $B = \vec{H}_1 + 4\pi\vec{M}$ and a kinetic equation for the operator $\hat{f}$ of electron density are to be solved. (The operator $\hat{f}$ acts only upon the spins).

$$\frac{\partial\hat{f}}{\partial t} + \frac{\partial\hat{f}}{\partial\vec{r}}\vec{v} + \frac{\partial\hat{f}}{\partial\vec{p}}\left\{e\vec{E} + \frac{e}{c}\left[\vec{v}\,\vec{H}\right]\right\} + \frac{i}{h}\left[\mu\vec{H}\vec{\sigma},\hat{f}\right] + \left(\frac{\partial\hat{f}}{\partial t}\right)_{col} + \left(\frac{\partial\hat{f}}{\partial t}\right)_{fw} = 0$$

Here $(\partial\hat{f}/\partial t)_{col}$ and $(\partial\hat{f}/\partial t)_{sp}$ denote the collision integral with and without spin exchange respectively, $\vec{\sigma}$ - the spin operator, $\vec{v}$ and $\vec{p}$ - velocity and momentum of the electron. For these collision integrals explicit expressions are then given.

ARBEL', M.YA.

537.311.31

1209\. TOWARDS THE THEORY OF THE ANOMALOUS SKIN EFFECT. M.I.Kaganov and M.Ya.Arbel'. Dokl. Akad. Nauk SSSR, Vol. 101, No. 1, 49-51 (1955). In Russian.

Recently a large number of papers have appeared discussing the dependence of the surface impedance $Z = (4\pi/c)(E/H)_0$ of metals on the mean free path of the conduction electrons. Sondheimer (Abstr. 7432/1954) introduced anisotropy of the metal by using anisotropic effective masses and obtained explicit expressions for the limiting case where the effective mean free path is considered infinite and the current considered due to electrons moving parallel to the surface of the metal. ... (Abstr. 7433/1954) obtained [illegible]

537.311.31

AZBYEL, M. YA

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PARAMAGNETIC RESONANCE AND THE POLARIZATION OF NUCLEI IN THICK METAL FOILS. M. Ya. Azbel', V. I. Gerasimenko, and I. M. Lifshitz (Academy of Sciences, Ukrainian SSR). Soviet Phys. JETP 4, 27[illegible]-9(1957) March.

3

It is shown that it is possible to polarize nuclei in thick foils at depths from 10^{-2} to 1 cm by means of a high-frequency high-intensity magnetic field. (S.A.H.)

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AZBEL' M. YA.

USSR/Electricity - Conductors G-4

Abs Jour : Ref Zhur - Fizika, No 1, 1958, 1378

Author : Azbel', M.Ya., Kaner, E.A.

Inst : Physico-Technical Institute, Academy of Sciences, Ukrainian SSR, Khar'kov.

Title : Theory of Cyclotron Resonance in Metals.

Orig Pub : Zh. eksperim. i teor. fiziki, 1957, 32, No 4, 896-914

Abstract : A study was made of a new type of resonance in metals, which takes place in high frequency electromagnetic fields and in a constant magnetic field parallel to the surface of the metal, when the frequency of the alternating field ω is a multiple of the cyclotron frequency Ω = eH/mc. The form of the resonant curve depends substantially on the law of dispersion of the electrons and makes it

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USSR/Electricity - Conductors G-4

Abs Jour : Ref Zhur - Fizika, No 1, 1958, 1378

possible to determine, from experimental data, the topology of the boundary of the Fermi surface and its actual characteristics. The surface impedance of the metal is calculated for an arbitrary direction of the constant magnetic field relative to the surface. The examination was carried out also under the most general assumptions of the electron theory of metals (arbitrary law of dispersion and collision intervals); it is shown that it is possible to introduce the mean-free-path time of the electrons under conditions of anomalous spin effect at all temperatures.

Card 2/2

The Heat Conductance and the Thermoelectric Phenomena in Metals in a Magnetic Field. 56-5-31/55

ductivity and the tensor of the Thomson's coefficients are listed. These interrelationships as obtained during the course of these computations are always valid, and they are not connected with the existence or nonexistence of a magnetic field. All kinetic coefficients depend on the temperature because of two reasons: firstly, because the shock integral depends on the temperature, and secondly, because the distribution function of the electrons which corresponds to the equilibrium depends on the temperature. Because of the always present strong degeneration of the electron gas it is of interest to compute the first nonvanishing terms of the expansion of these coefficients with respect to the powers of the small parameter T/ζ_0. This computation is discussed in the paper under review, and the results are given. If the shock operator is a δ-function with respect to the energies, then these expressions are greatly simplified. For the asymptotic values of the components $\varkappa_{xy}$ and σ_{xy} ($\varkappa_{xy}$ denotes the tensor of the heat conductivity) the Wiedemann-Franz law is always valid. (No reproductions)

ASSOCIATION Physical-Technological Institute, Academy of Sciences of the UkrainianSSR

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SUBMITTED 9.7.1956

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Card 2/2

AZBEL'Y M. Ya.

56-5-35/55

AUTHOR AZBEL', M.Ya., GERASIMENKO, V.I., LIFSHITS, I.M.

TITLE The Paramagnetic Resonance and the Polarization of Nuclei in Metals.
(Paramagnitnyy rezonans i polyarizatsiya yader v metallakh - Russian)

PERIODICAL Zhurnal Eksperim.i Teoret.Fiziki, 1957, Vol 32, Nr 5, pp 1212-1225 (U.S.S.R.)

ABSTRACT The Theory of the paramagnetic resonance, as constructed in the paper under review, is based on the simultaneous solution of the Maxwell's equations and of the kinetic equation for the density operator. The paper under review also determines the degree of polarization of the nuclei in a metal and the coefficient of transparency of metallic films, taking into account the diffusion of the spins. This problem is solved by means of the system of the Maxwell's equations rot $\vec{E} = -(1/c)\partial\vec{B}/\partial t$; rot $\vec{H} = (4\pi/c)\vec{j}$; $\vec{B} = \vec{H}_1 + 4\pi\vec{M}$, and of the kinetic equation for the operator of the electron density $(\partial f/\partial t) + \vec{v}(\partial f/\partial\vec{r}) + \partial f/\partial\vec{p}\left\{e\vec{E} + (e/c)\left[\vec{v}\vec{B}\right]\right\} + (i/\hbar)\left[\partial\hat{\mathcal{H}}, f\right] + (\partial f/\partial t)_{st} = 0$; $\hat{\mathcal{H}} = \mu\hat{\vec{\sigma}}\vec{B}$; $\vec{B} = \vec{B}_0 + \vec{B}_1(\vec{r}, t)$; $\vec{v} = \nabla_p \mathcal{E}(p)$. In this context, $\mathcal{E}$, $\vec{p}$ and $\vec{v}$ denote the energy, the quasiimpulse and the velocity of the electrons, respectively; $\hat{\sigma}$ stands for the operator of the spin, and $(\partial f/\partial t)_{st}$ for the shock integral of the electrons. For f also a boundary condition is given. By solving the kinetic equation one obtaines a connection between the current density $\vec{j}$, the electrical field strength $\vec{E}$, the magnitic spin moment $\vec{M}$, and

Card 1/2

AZBEL, M. YA.

56-5-52/55

AUTHOR AZBEL', M.Ya.

TITLE On the Theory of the Skin Effect in Metals.
(K teorii skin-effekta v metallakh -Russian)

PERIODICAL Zhurnal Eksperim.i Teoret.Fiziki,1957,Vol 32,Nr 5,pp 1259-1259(USSR)

ABSTRACT It is usual to assume $\vec{B}=\vec{H}$ when constructing the theory of the skin effect in metals,because the magnetical susceptibility of metals is very small ($\chi\sim 10^{-6}$).But to neglect the spin paramagnetism of the free electrons means to commit a considerable error in the determination of the coefficient of transition of an electromagnetic wave through a sufficiently thick film.This can be explained in the following way:The magnetic moment connected with spin paramagnetism ceases to exist in the depth $\delta_{eff}\sim v\left[t_0 T_{sp}/3(1+\omega T_{sp})\right]^{1/2}$.In this context,v denotes the Fermi's boundary velocity of the electrons,ω stands for the velocity of the electromagnetic field,and t_0 and T_{sp} denote the times of the free length of path of the electrons without and with spin exchange,respectively.Because the usual depth of the skin layer amounts to $\delta\sim\sqrt{c^2/2\pi\omega\sigma}$, we have $\delta/\delta_{eff}\lesssim(c/vt_0)\sqrt{m/2\pi ne^2}\sim$ $\sim 10^{-14}sec/t_0\ll 1$. In this context,n,m and e denote the density,the effective mass,and the charge,respectively,of the electron,and σ stands for the conductance of the metal.Consequently consideration of the magnetic moment caused by the spin leads to an additional term which,although small,ceases to exist only slowly.In this context,the paper under review computes,taking into account this additional term,the coefficient of the transition of the wave through a sufficiently thick film ($d\gtrsim 2\delta\ln(\delta_{eff}/4\pi\chi\delta)$).In this case,the com-

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On the Theory of the Skin Effect in Metals. 56-5-52/55

plete system of the equations has the following form: rot $\vec{E} = -i\omega\vec{B}/c$; rot $\vec{H} = 4\pi\vec{j}/c$; $\vec{H} = \vec{B} - 4\pi\vec{M}$; $\vec{M} = \chi(\vec{B} - \vec{w})$. $\frac{\partial \vec{w}}{\partial z} v \cos\theta + \frac{\vec{w}}{t_0^*} = \frac{\bar{w}}{t_0} + i\omega\vec{B}$;

$\frac{1}{t_0^*} = \frac{1}{t_0} + \frac{1}{T_{sp}} + i\omega$; $\bar{f} = \frac{1}{2}\int_0^\pi f \sin\theta\, d\theta$. The solution of this system is completely analogous to the solution of the system(26) in the paper by M.Ye.Azbel', V.I.Gerasimenko, I.M.Lifshits, Zhurn.eksp.i teor.fis., Vol 32, Nr 5, p 1212(1957), and leads to the following formulae for the coefficient of transition:

$K \sim \left| \frac{\chi c^3 z^2}{2\pi d(\omega + 1/T_{sp})} \right|$, $2\delta \ln \frac{\delta_{eff}}{4\pi\chi\delta} \ll d \ll \delta_{eff}$. In particular, we have at normal skin effect and with $\omega \gg 1/T_{sp}$: $K \sim \left(\frac{2\chi c}{\sigma d}\right)^2 \gtrsim \frac{2\pi\chi^2\omega}{\sigma} \ln^{-2} \frac{c}{v\sqrt{2\pi\sigma t_0}} \sim 10^{-17}$. This abstract is a translation of the short note under review.

(No reproduction).

ASSOCIATION Physical-Technological Institute, Academy of Sciences of the Ukrainian SSR

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SUBMITTED 18.2.1957

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Card 2/2

56-3-37/59

On the Theory of the Paramagnetic Resonance of Electrons in Superconductors

of massive superconductors is impossible. For the purpose of enabling an observation of the paramagnetic resonance on a superconductor, $d < \delta_0$ must be true for the thickness d of the superconductor. (The experimental determination of a paramagnetic resonance on massiv superconductors would signify that the resonance is caused by the superconductive electrons). For the determination of the law of damping of the high-frequency and the constant magnetic field an equation given in a previous paper has to be solved. For normal electrons in no case resonance exists at $\omega_0 \delta_0 / v \ll 1$. The spin diffusion of normal electrons even in the case of superconductors leads to the occurrence of a small, slowly damped term in expressions for the alternating field and for the constant field. At $z \gg \delta_0$ the magnetic field in a superconductor is damped considerably more slowly than it appears according to the usual theory by London. There are 5 references, 3 of which are Slavic.

ASSOCIATION: Physical-Technology Institute, AN Ukrainian SSR (Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR)

SUBMITTED: June 13, 1957

AVAILABLE: Library of Congress

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56-6-22/47

On the Theory of Cyclotron Resonance in Metals

3.) On non-elliptical surfaces resonance frequency corresponds to a maximum of p_x, on the effective mass of $(1/2\pi)(\partial S/\partial \epsilon)_{max}$.
4.) At frequencies which correspond to the foci of the elliptical surfaces, resonance occurs with a polarization of the electric wave along the direction $\vec{H}$.
5.) At frequencies which correspond to the central cross section, resonance occurs with a polarization of waves only along the direction of the limit velocity at the point $p_x = v_x = 0$.
6.) At frequencies which correspond to the extreme values of the effective mass in the central cross section $-\mathcal{E}(\vec{p}) = \xi$, p_x = const. resonance occurs at any polarization of the electromagnetic wave.
7.) The relative depth of resonance in the case of a maximum effective mass is $R_{reson}/R^{(o)} \sim (\omega\tau_o)^{-1/6}$; $X_{reson}/X^{(o)} \sim (\omega\tau_o)^{-1/6}$
in the case of a minimum effective mass:

$$R_{reson}/R^{(o)} \sim (\omega\tau_o)^{-4/9}; \quad X_{reson}/X^{(o)} \sim (\omega\tau_o)^{-1/4}$$

8.) Further conclusions concerning the dependence of impedance on the magnetic field and the law of dispersion are also mentioned. There are 4 figures, and 13 references, 8 of which are Slavic.

Card 2/3 Inst. Radiophysics & Electronics AN UkSSR

AZBEL', M.Ya., Doc Phys-Math Sci-- (diss) "Theory of high frequency conductivity of metals in a constant magnetic field." Khar'kov, 1958. 13 pp (Acad Sci USSR. Inst of Phys Problems im S.I.Vavilov), 130 copies Bibliography: p 13 (34 titles) (KL, 24-58, 115)

SOV/56-34-3-38/55

AUTHOR: Azbel', M. Ya.

TITLE: On the Problem of the Restauration of Form of the Fermi-Surface in Metals (K voprosu o vosstanovlenii formy Fermi--poverkhnosti v metallakh)

PERIODICAL: Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, 1958, Vol. 34, Nr 3, pp. 754 - 755 (USSR)

ABSTRACT: The determination of the form of the Fermi-surface $\varepsilon(\vec{p}) = \varepsilon_0$ from the experimental results is of great importance for theory. In this case ε or $\vec{p}$ respectively, denote the energy or the quasi-momentum of the conduction electron respectively, and ε_0 denotes Fermi's limiting energy. I. M. Lifshits and A. V. Pogorelov (Reference 1) proposed a method for such a determination of the Fermi-surface from the extremum surfaces S_{ext} of the cuttings of the Fermi-surface. These surfaces can be determined from the periods of the oscillations of the magnetic susceptibility χ with the effect of de Haas-van Alfvén (De Gaaz-van Al'fen). But the harmonic analysis

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SOV/56-34 3-38/55

On the Problem of the Restauration of Form of the Fermi-Surface in Metals

of the experimental curves χ (H) is rather difficult on account of the number of harmonics which is, as a rule, great. The present work gives a method for the immediate determination of S_{ext} for various harmonics, and of the radius vector of the p-surface as function of the direction $\vec{p}/p$. The author investigates here the effect by de Haas - van Alfvén in a film in a constant magnetic field orientated at random. For the sake of briefness it is assumed that the Fermi-surface represents a closed convex surface. If the track corresponding to the central cutting "has no place" in the film of the thickness D, all electrons collide with their surface and the amplitude of the quantum oscillations of χ and is proportional to an at least second power of $\mu H/\varepsilon_0$ (μ denotes Bohr magneton for the conduction electron). But if the track corresponding to the central cutting "has place" in the film, the electrons corresponding to the central cutting (which contribute to the quantum oscillation) do not collide with the surface. Their energy spectrum agrees in the quasi-classical case with the spectrum in a massive metal and the amplitude of the corresponding quantum oscillations is proportional to $(\mu H/\varepsilon_0)^{3/2}$. The magnetic moment differs

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then from the magnetic moment of a massive metal only by the fact that the difference D - d instead of D enters the formulae. With the method discussed here, d and S_{ext} are thus determined separately for each plane and the harmonic analysis is not applied. Also the values of S_{ext} allow the determination of the Fermi-surface according to the method by Lifshits-Pogorelov. There are 1 figure and 4 references, 4 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physical-Technical Institute AS Ukrainian SSR)

SUBMITTED: November 26, 1957

SOV/56-34-3-45/55

AUTHOR: Azbel', M. Ya.

TITLE: On the Theory of Surface Impedance of Metals With Anomalous Skin-Effect (K teorii poverkhnostnogo impedansa metallov pri anomal'nom skin-effekte)

PERIODICAL: Zhurnal Eksperimental'noy i Teoreticheskoy Fiziki, 1958, Vol. 34, Nr 3, pp. 766 - 767 (USSR)

ABSTRACT: A theory of the surface impedance under the conditions of anomalous skin-effect was developed in 2 previous works (References 1, 1a) in which case the smallest characteristic value of the problem is the depth δ of the skin-layer. In this connection the electrons in the metal are considered an ideal gas of Fermi quasiparticles with the law of dispersion $\mathcal{E} = \mathcal{E}(p)$. $\mathcal{E}$ denotes here the energy and p - the quasi-impulse of the particle. In reality, the interaction of the electrons is not small at all, for which reason the conduction electrons are to be considered a Fermi-liquid. The formulae for the current density and for the kinetic energy are written down and briefly discussed. The electrons

Card 1/2

SOV/56-34-3-45/55

On the Theory of Surface Impedance of Metals With Anomalous Skin-Effect

of the Fermi-liquid and of the Fermi-gas give the same results in zeroth approximation with respect to anomaly. The correctness of this assertion can also be confirmed by means of a substitution given here. There are 4 references, 3 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk USSR (Physical-Technical Institute AS Ukrainian SSR)

SUBMITTED: December 17, 1957

Card 2/2

AUTHOR: Azbel', M. Ya. 56-34-4-29/60

TITLE: The Quantum Theory of the High Frequency Conductivity of Metals (Kvantovaya teoriya vysokochastotnoy provodimosti metallov)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol. 34, Nr 4, pp. 969 - 983 (USSR)

ABSTRACT: In this paper the theory for the general case that an inhomogeneity exists in space which is in connection with the non-steady stall of the electric field. Inhomogeneity is here assumed to be essential, i.e. that the depth δ of the skin layer is assumed to be very small compared to the Larma-radius r and the free length of path 1 of the electrons. Thus, the so called anomalous skin effect is concerned. At helium-temperatures, when quantum oscillations are observed, this is the case even with ultra short waves. At the same time in the inhomogenous case specific, essential difficulties arise in connection with the following fact: Hitherto it has not been known, how it is possible to represent the quantum mechanical problem of determination of the energy spectrum and of the matrix elements for a bounded metal-test, if the reflection of the electrons on

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the walls of that sample diffuse in the classical sense. This problem can be solved because only such electrons as do not collide with the surface make an essential contribution towards the quantum-like additional term to the classical current density. The complete system of equation for the determination of electric conductivity consists of the Maxwell equations and of the kinetic equations for the statistical operator $\hat{f}$. Also for the connection between current density $\hat{j}$ and $\hat{f}$ a formula is given in quasiclassical approximation. The system of equations which results in quasiclassical approximation is explicitly written down. This problem is reduced to the computation of the quasiclassical matrix elements. The following two chapters deal with the solution of the problem in the case of mirror-like or also any reflexion of the electrons on the surface of the metal. An essential contribution is made towards the quantum like oscillating additional term only by such electrons as satisfy, at the same time, the following conditions: The average (with respect to the period of revolution in the orbit) velocity of their motion into the depth of the metal is low. The surface S of the cross sections corresponding with their orbits is al-most equal to the extreme value $S_{extreme}$. In the course of their motions the electrons do not collide with the surface. In the last chapter the quantum-like additional term to the current density is computed. There are 14 references, 12 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology, AS UkrSSR)

SUBMITTED: November 26, 1957

1. Metals--Conductivity

AUTHOR: Azbel', M. Ya. SOV/56-34-5-16/61

TITLE: The Quantum Oscillations of a High Frequency Surface Impedance (Kvantovyye ostsillyatsii vysokochastotnogo poverkhnostnogo impedansa)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958 Vol. 34, Nr 5, pp. 1158-1168 (USSR)

ABSTRACT: The author derives a quantum formula for the total surface impedance of metals for high frequencies on the basis of the general formulae previously obtained by the author (Ref 1). First the total surface impedance is calculated. By solving a system of Maxwell equations (which, in the discussed case, can be reduced to the equations

$$E''_{\alpha}(\xi) = 4\pi i\omega c^{-2} j_{\alpha}(\xi), \ (\alpha = x, \xi), \ j_{\zeta}(\xi)=0)$$

with the following relation between the current density and the electrical field strength $j_i(\xi) = j_i^{classical}(\xi) + \Delta j_i^{quantum}(\xi)$ it is possible to determine the total surface impedance. ξ denotes the direction in the metal plane that is perpendicular to x. First the case of the semispace is investigated. For the

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anomalous skin effect only great k and k' are important. The calculations may be simplified in the most important case of a strong magnetic field with resonance. Formulae are given for the impedance. According to these formulae the case with equal numbers of holes and electrons ($N_1=N_2$) is not a special state. The formulae derived in this paper give the zero approximation and the first approximation of the impedance with respect to $(\mu H/\mathcal{E}_0)^{1/2}$ and the zero approximation with respect to δ_{eff}/r. All the derived formulae hold also for not too thin films on which an electromagnetic wave falls from one side. If the film is too thin, the amplitude of the quantum oscillations with the corresponding period is equal to zero in the considered approximation. In the next part the quantum oscillations of the surface impedance in the magnetic field perpendicular to the surface are calculated on the assumption of a quadratic dispersion. The quantum additional term to the surface impedance in zero approximation is purely real. The last two parts of this paper discuss the possibilities of reestablishment of the Fermi surface and the quantum oscillations of the static conduction in films. The amplitudes of the quantum oscillations dR/dH and dX/dH are

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The Quantum Oscillations of a High Frequency Surface Impedance SOV/56-34-5-16/61

$(\mathcal{E}_0/\mu H)^{1/2}$ times greater than its classical value. In a magnetic field exactly parallel to the surface $(\pi/2-\varphi \ll \delta_{eff}/l)$ the periods of the oscillations are caused by all the extremal cross sections of the Fermi surface but in an inclined magnetic field only by the central cross sections. At least a formula is given for the tensor of the surface impedance. The author thanks I. M. Lifshits and L. D. Landau for useful discussions. There are 8 references which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physical-Technical Institute, AS UkrSSR)

SUBMITTED: November 26, 1957

1. Metals--Electrical properties 2. Oscillations--Theory
3. Impedance--Measurement 4. Mathematics--Applications

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24(3) SOV/56-35-3-20/61

AUTHORS: Azbel', M. Ya., Gerasimenko, V. I., Lifshits, I. M.

TITLE: On the Theory of Paramagnetic Resonance in Metals (K teorii paramagnitnogo rezonansa v metallakh)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 3, pp 691-702 (USSR)

ABSTRACT: Paramagnetic resonance may occur if a metal is located in a steady magnetic field H_0 and in a variable electromagnetic field H_1, in which case the following must apply to the frequency of the variable field: $\omega = \Omega_0 \equiv 2\mu H_0/\hbar$. The absorption of the energy of the electromagnetic waves impinging upon the metal under the conditions of paramagnetic resonance has already been investigated by a number of experiments (e.g. Ref 2). The first theoretical investigation of this problem together with the calculation of electron diffusion from the surface layer was carried out by Dyson (Dayson) (Ref 3). The authors of the present paper developed a general theory of paramagnetic resonance in an earlier paper (Ref 1); it is based upon the

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solution of the equation for the electron density operator. The electrons are looked upon as a gas of noninteracting quasiparticles; for $\varepsilon(\vec{p})$ any dispersion law applies, and also the direction of H_0 and the intensity of H_1 may be chosen at random. In the present paper the authors, basing upon the results obtained by the preceding paper (Ref 1), investigate the dependence of surface impedance on the angle of inclination of the steady magnetic field to the metal surface, and further also the influence exercised by the dispersion law on impedance, and the case of sufficiently strong variable fields (resonance saturation). The following cases are dealt with: 1) In the interval $\Delta\varepsilon$ there are no open surfaces; 2) in $\Delta\varepsilon$ there are open and closed isoenergetic surfaces ($\varepsilon(\vec{p}) = \varepsilon$), and 3) in $\Delta\varepsilon$ there are only closed isoenergetic surfaces. Calculations are at first carried out for $\delta \ll \delta_{eff}$ (δ = skin depth, δ_{eff} = depth of electron diffusion); $\delta \gtrsim \delta_{eff}$ (range of normal skin effect, $j = \sigma E$) is dealt with in an appendix. It is found that in strong H_0-fields surface impedance depends essentially on the angle of inclination between the H_0-direction and the metal surface.

On the Theory of Paramagnetic Resonance in Metals SOV/56-35-3-20/61

There are 1 figure and 7 references, 5 of which are Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physico-Technical Institute of the Academy of Sciences, Ukrainskaya SSR)

SUBMITTED: March 29, 1958

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AZBEL', M. YA.

24(0) SOV/30-59-2-42/60

AUTHOR: Khalatnikov, I. M., Doctor of Physical and Mathematical Sciences

TITLE: Investigations of Low-temperature Physics (Issledovaniya po fizike nizkikh temperatur)

PERIODICAL: Vestnik Akademii nauk SSSR, 1959, Nr 2, pp 98-100 (USSR)

ABSTRACT: The 5th All-Union Conference on this problem took place in Tbilisi from October 27 to November 1, 1958. It was attended by physicists from Moscow, Khar'kov, Leningrad, Tbilisi, Sverdlovsk, and Kiyev. 4 fields of low-temperature physics were discussed: superliquidity of liquid helium II, supraconductivity, antiferromagnetism, magneto-resistive effect. The following reports and communications were heard: A. A. Abrikosov, L. P. Gor'kov reported on the investigation of the properties of supraconductive alloys. A. A. Abrikosov, L. P. Gor'kov, I. M. Khalatnikov spoke of properties of supraconductors in the high-frequency magnetic field. D. V. Shirkov and Chen' Chun'-yan' and Chzhou Si-shin', two young Chinese scientists working at Moscow University, described investigations for determination of the influence exercised by the Coulomb (Kulon) interaction of charges on supraconductivity. V. V. Tolmachev explained the

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nature of the so-called collective excitations of the Bose type in supraconductors. D. N. Zubarev, Yu. A. Tserkovnikov spoke of the thermodynamics of supraconductors and B. T. Geylikman, V. Z. Kresin of the thermal conduction of supraconductors. Yu. V. Sharvin, V. F. Gantmakher reported on experimental work with supraconductors. N. V. Zavaritskiy spoke of the measurement of the anisotropy of thermal conductivity in the supraconductive state. In a series of reports problems of the superliquidity of helium were discussed, which was discovered in 1938 by P. L. Kapitsa and the theory of which was set up in 1941 by L. D. Landau. E. L. Andronikashvili and his collaborators investigated the properties of rotating helium. V. P. Peshkov spoke of the effect of the formation of the boundary between superliquid and non superliquid helium. Guan Vey-yan', collaborator of the Institut fizicheskikh problem (Institute of Physical Problems) investigated the properties of the so-called jump in temperature of Kapitsa. I. M. Lifshits, V. D. Peschanskiy investigated galvanomagnetic phenomena in strong magnetic fields for metals with open Fermi surfaces. N. Ye. Alekseyevskiy, Yu. P. Gaydukov experimentally investigated the resistance anisotropy of gold monocrystals in the magnetic field. L. S. Kan, B. G. Lazarev combine the presence of a temperature minimum with the structural state of the metal. M. Ya. Azbel' reported on the quantum theory of metallic conductivity in the alternating electromagnetic and constant magnetic field. A. S. Borovik-Romanov reported on the weak ferromagnetism in antiferromagnetic samples of $MnCO_3$. N. M. Kreynes,

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Ye. A. Turov investigated the magnetic anisotropy of the antiferromagnetic monocrystals $CuSO_4$ and $CoSO_4$. A. A. Alikhanov reported on neutronographic investigations of antiferromagnetics. Ya. I. Kondorskiy and collaborators reported on the susceptibility of nickel and nickel-copper alloys at low temperatures. M. I. Kaganov, V. M. Tsukernik reported on kinetic phenomena in ferromagnetics at low temperatures. A. I. Akhiyezer, V. G. Bar'yakhtar, and S. V. Peletminskiy spoke of computations of the relaxation of the magnetic moment in ferromagnetic dielectrics at low temperatures. T. I. Sanadze spoke of observation results of paramagnetic resonance of terbium in the $TbNO_3 \cdot 6H_2O$ nitrate. G. R. Khutsishvili gave a theoretical analysis of the orientation of the nuclear spin in the Overhauser (Overkhauzer)

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effect in nonmetals. B. S. Samoylov, N. M. Reynov and collaborators reported on obtaining orientated nuclei. N. P. Bulatova, V. S. Kogan and B. G. Lazarev showed that hydrogen isotopes in solid state have different structures. I. A. Gindin, B. G. Lazarev, Kh. D. Starodubov and V. I. Khotkevich detected polymorphism in a number of metals at low temperatures. E. L. Andronikashvili, V. P. Peshkov and M. P. Malkov reported on the stage of development of foreign scientific research work in the field of low-temperature physics. At the end of the Conference P. L. Kapitsa spoke of his successful development of investigations in the field of low-temperature physics. The participants of the Conference visited the Institut fiziki Akademii nauk Gruzinskoy SSR (Physics Institute of the Academy of Sciences of the Gruzinskaya SSR) and the Physics Faculty of Tbilisi University as well as the building of the new research atomic reactor near Tbilisi.

24(0) SOV/53-67-4-7/7

AUTHOR: Chentsov, R.

TITLE: The Fifth All-Union Conference on the Physics of Low Temperatures (5-ye Vsesoyuznoye soveshchaniye po fizike nizkikh temperatur)

PERIODICAL: Uspekhi fizicheskikh nauk, 1959, Vol 67, Nr 4, pp 743-750 (USSR)

ABSTRACT: This Conference took place from October 27 to November 1 at Tbilisi; it was organized by the Otdeleniye fiziko-matematicheskikh nauk Akademii nauk SSSR (Department of Physico-mathematical Sciences of the Academy of Sciences, USSR), the Akademiya nauk Gruzinskoy SSR (Academy of Sciences, Gruzinskaya SSR), and the Tbilisskiy gosudarstvennyy universitet im. Stalina (Tbilisi State University imeni Stalin). The Conference was attended by about 300 specialists from Tbilisi, Moscow, Khar'kov, Kiyev, Leningrad, Sverdlovsk, and other cities as well as by a number of young Chinese scientists at present working in the USSR. About 50 lectures were delivered which were divided according to research fields.

III. Galvanomagnetic phenomena. (10 lectures). I. M. Lifshits and V. D. Peschanskiy (KhFTI, Khar'kov Physico-technical Institute, Khar'kov University) showed that the most important part in connection with the galvanomagnetic properties of metals is played by the concrete form of the Fermi surface of conductivity electrons. N. Ye. Alekseyevskiy (IFP) spoke about experiments he carried out together with Yu. P. Gaydukov. He investigated the variation of the resistance in the transversal magnetic field at helium temperatures of Au, Cu, Pb, Te, Ga, Ni and (together with T. I. Kostina) of Bi. Ye. S. Borovik and V. G. Volotskaya (KhFTI) investigated the galvanomagnetic properties at low temperatures of chromium and zirconium and found that the resistance of chromium grows with field strength without at-

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taing a saturation value. L. S. Kan and B. G. Lazarev (KhFTI) investigated the resistance minimum in gold at low temperatures and found that if the sample is heated, the minimum disappears. Yu. P. Gaydukov (IFP) said in this connection in the course of the discussion that the minimum effect does not occur in gold in the case of very pure samples; the disappearance of the minimum is explained by the plastic deformation of the sample at helium temperatures. M. Ya. Azbel' (KhFTI) gave a report of his work in connection with the quantum theory of the high-frequency resistance of metal in a constant magnetic field at low temperatures. M. I. Kaganov and V. M. Tsukernik (KhFTI) spoke about a theoretical investigation of the influence exercised by thermoelectric forces upon the skin effect in various conductors. B. I. Verkin and B. N. Aleksandrov (KhFTI) spoke about measurements of the electric resistance of thin wires made from highly-pure tin, indium and cadmium, and computed the free length of path at 4.2°K in these metals as amounting to 1/3 to 2/3 mm. N. B. Brandt (MGU) and B. I. Verkin and I. M. Dmitrenko (KhFTI) investigated the influence exercised by the hydrostatic pressure (of 1000 atmospheres absolute pressure) upon the behavior of metals at low temperatures and investigated

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the quantum oscillations of the magnetic susceptibility of bismuth at 1.6 - 4.2°K. G. Ye. Zil'berman and A. M. Kosevich (KhFTI) gave a theoretical explanation of the fact that already relatively small deformations exercise considerable influence upon oscillation effects in metals. IV. Magnetism. A. S. Borovik-Romanov (IFP) delivered a report on investigations he carried out of the anisotropy of the weak ferromagnetism in monocrystal samples of the antiferromagnetic $MnCO_3$ (the effect of anisotropy was predicted by the thermodynamical theory developed by Dzyaloshinskiy). In the course of the discussion R. A. Alikhanov (IFP) spoke about neutronographical investigations he carried out of the magnetic structure of $MnCO_3$ and $FeCO_3$ at low temperatures. P. L. Kapitsa stressed the importance of the method based upon Dzyaloshinskiy's theory. N. V. Zavaritskiy (VNIIFTRI), whose lecture was read by A. S. Borovik-Romanov, reported on measurements carried out by him (in the IFP) of the magnetic anisotropy of the antiferromagnetic $CuSO_4$- and $CoSO_4$-monocrystals.

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Ye. A. Turov (IFM AN SSSR, Sverdlovsk) spoke about his theore-

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Azbel', M. Ya.

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AUTHORS: Gurzhi, R. N., Azbel', M. Ya.

TITLE: Electron Relaxation Time in a High-frequency Electromagnetic Field and the Surface Impedance of a Metal

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 2, pp. 524 - 528

TEXT: The authors investigated the influence of quantization of the electromagnetic field and the electron orbits in a constant magnetic field on the relaxation time of electrons in a metal in connection with electron-phonon interactions, and again this influence on the surface impedance of the metal. The first part of the present paper deals with the influence of quantum effects on the electron-phonon collision frequency. Only the results of an exact analysis of the respective equations are discussed, first of all, for the normal skin-effect region (free path length $l \ll$ skin depth δ) and for the infrared region ($v/\omega \ll$ skin depth), since analysis is relatively simple in this region.

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Electron Relaxation Time in a High-frequency Electromagnetic Field and the Surface Impedance of a Metal

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Quantum effects are inconsiderable in the first case, and it is likewise found in the second case that the quantization of electronic levels in the magnetic field exerts no appreciable influence either. The effect of quantization of the electromagnetic field in the infrared region had been investigated already earlier (Ref. 4). Concerning the anomalous skin-effect region ($l \gg \delta$) several general considerations are discussed (classical effects and quantum effects, with and without magnetic field). Only the case of $\Omega \ll \omega$ is dealt with here, namely, in the second part of the paper, which is devoted to an investigation of the relaxation time with cyclotron resonance in metals (Ω - cyclotron frequency). The anomalous skin effect in the presence of a constant magnetic field parallel to the metal surface had already been investigated by M. Ya. Azbel' and E. A. Kaner, and expressions had been derived for the surface impedance in arbitrary fields. Only the limiting cases of weak and strong magnetic fields are briefly dealt with here, whereas the resonance region, where surface impedance is considerably dependent on relaxation time, is investigated in greater detail. Quantization in the magnetic field is not considered. The results obtained only refer

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Electron Relaxation Time in a High-frequency Electromagnetic Field and the Surface Impedance of a Metal

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to the harmonics of the cyclotron resonance ($\omega \approx 2\Omega$, 3Ω, ...) with $\Omega < \omega$, and provided that $k\Theta \gg \hbar\omega \gg kT$. Orbit quantization is found to be of essential importance only in the region of the anomalous skin effect, namely, at $\Omega \gtrsim kT/\hbar$. Electromagnetic field quantization is always considerable in the infrared region and in the region of the anomalous skin effect in the presence of a constant magnetic field (in the entire region of the magnetic fields if $\omega \sim \Omega$, and only with cyclotron resonance if $\omega \gg \Omega$). There are 9 references: 7 Soviet, 1 American, and 1 Canadian.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences of the Ukrainskaya SSR)

SUBMITTED: August 12, 1959

Card 3/3

83595

S/056/60/038/005/028/050
B006/B070

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AUTHORS: Rozentsveyg, L. N. (Deceased), Azbel', M. Ya.

TITLE: The Problem of Preparing a Polarized Hydrogen Target 19

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 38, No. 5, pp. 1556 - 1558

TEXT: M. Ya. Azbel', V. I. Gerasimenko, and I. M. Lifshits (Ref. 1) have shown that the method of Overhauser for nuclear polarization is not confined to very small samples (thickness d of the order of skin depth $\delta \sim 10^{-4}$ cm). An exact theoretical investigation of the paramagnetic resonance of conduction electrons in compact metallic samples showed that the ideas on the possibilities in principle of Overhauser's method as well as those on the choice of the optimal conditions must be revised. Accordingly, the sample thicknesses polarizable by this method are considerably larger. If the constant magnetic field is not exactly parallel to the surface of the metal, $d \sim \delta_{eff} \sim v\sqrt{t_o T_s}$ holds (v is the

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The Problem of Preparing a Polarized Hydrogen Target

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necessary to study the hydride experimentally. The authors give suggestions for experimental investigations of this kind. $Z(H_0)$ and $k(H_0)$ must be experimentally determined for a sample ($d \ll \delta_{eff}$). From the formulas given here, T_s and t_0/T_s may be determined, and from these again, δ_{eff}. An observation of the selective transmissivity provides an additional method for the checking of polarization which can be determined from formula (5) of Ref. 1. The method may be also used to prepare deuterium and tritium targets. Finally, another effect is discussed, which was detected by Ye. K. Zavoyskiy. There are 4 references: 1 Soviet and 3 US.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk SSSR (Institute of Physics and Technology of the Academy of Sciences USSR)

SUBMITTED: December 7, 1959

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Azbel', M. Ya.

S/056/60/039/01/13/029
B006/B070

AUTHORS: Azbel', M. Ya., Kaner, E. A.

TITLE: The Problem of the Experimental Investigation of Cyclotron Resonance in Metals 21

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 1 (7), pp. 80-87

TEXT: Up to now cyclotron resonance has been experimentally observed in seven metals: tin, lead, indium, bismuth (and its compounds with tin and thallium), copper, zinc, and aluminum. On this subject there exist many experimental and theoretical works. The aim of the present paper is to discuss the data in these publications and to compare them with the theoretical predictions. Some further possibilities of experimentally investigating cyclotron resonance in metals are also mentioned. The general theory of the effect is then given, and the determination of the effective carrier mass, the form of the resonance curve, and the law of dispersion are briefly dealt with. In the following, experimental facts are compared with theoretical predictions. The theoretically predicted

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The Problem of the Experimental Investigation of Cyclotron Resonance in Metals

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results are compared with the theoretical ones. It is then pointed out that the dependence of absorption on the direction of polarization of a variable electric field, when the direction of $\vec{H}$ is kept constant, has not yet been investigated. A few problems concerning Fermi surface are discussed, and it is shown that the solution given in Refs. 17 and 18 for the equation of motion of the electron in a magnetic field parallel to the metal surface does not satisfy the boundary conditions. In conclusion, the authors thank A. F. Kip, D. N. Langenberg, E. Fawcett and I. Phillips for making available the preprints before publication. P. A. Bezuglyy, A. A. Galkin, M. S. Khaykin, N. Ye. Alekseyevskiy and Yu. P. Gaydukov are mentioned. There are 2 figures, 1 table, and 37 references: 17 Soviet, 15 American, 3 British, and 1 Canadian.

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ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physicotechnical Institute of the Academy of Sciences of the Ukrainskaya SSR)

SUBMITTED: December 16, 1959

Card 3/3

83191

A New Resonance Effect in Metals at High Frequencies

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oscillations of j and E cover distances of the order of d with a damping depth of the order of d^2/δ_0. The phenomenon shown in Fig. 2 is thoroughly investigated theoretically, and the determination of the field strength in a metal, the investigation of the field structure in a metal, the nature of field "flash-ups", and the natural frequencies of plasma oscillations, as well as the surface impedance are studied individually. In this connection, the author predicts several new phenomena and discusses possibilities of their experimental verification. This concerns, above all, resonance effects of impedance: If the resonance conditions are satisfied, discontinuities (jumps) of resonance impedance must occur, and also discontinuous (jump-like) disappearance of resonance on harmonics in plates of a thickness of $D \gg d$. Experimentally, the derivatives of the impedance components ($Z = R + iX$) with respect to H are easily measurable; the change in these derivatives in a magnetic field is to develop (as predicted by theory) not monotonically but also interrupted by "flash-ups". These effects occur, 1) with increasing frequency of the alternating field, 2) with the rotation of a constant magnetic field in the plate plane, 3) an effect due to those "flash-ups" is the selective transmissivity of the plates in the case of resonance, and 4) an effect is the "spatial

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A New Resonance Effect in Metals at High Frequencies

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electron echo" analogous to the spin echo. By investigating the impedance of the plates, a direct construction of the Fermi surface is possible. It is also shown that in a number of semiconductors and poor metals not diamagnetic but cyclotron resonance occurs. The author thanks I. M. Lifshits for discussions. There are 5 figures and 4 references: 2 Soviet, 1 US, and 1 British.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences Ukrainskaya SSR)

SUBMITTED: March 7, 1960

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B006/B063

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AUTHOR: Azbel', M. Ya.

TITLE: Quantum Oscillations of Thermodynamic Quantities for an Arbitrary Fermi Surface

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 3(9), pp. 878-887

TEXT: The purpose of the present work was to calculate some thermodynamic quantities of an electron gas that is placed in a constant magnetic field $\vec{H}(0,0,H)$ for the case of a non-convex Fermi surface. The dispersion law $\varepsilon = \varepsilon(\vec{p})$ is supposed to be arbitrary (ε - energy, $\vec{p}$ - quasi-momentum). In the introduction, the author discusses the results of a paper by I. M. Lifshits and A. M. Kosevich (Ref. 1), in which it was shown that, as a result of the strong Fermi degeneracy of the electron gas, the quantization of the electron energy levels in metals turns the additional term to the thermodynamic quantities into a periodic function of $1/H$ (for $\varepsilon = \varepsilon(\vec{p})$ and $\vec{H}(0,0,H)$ = const). Here, the author calculates the thermodynamic potential Ω and the magnetic susceptibility in the general case

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Quantum Oscillations of Thermodynamic Quantities for an Arbitrary Fermi Surface

for self-interacting orbits, and shows that quantum oscillations of these quantities occur in this case, which depend on H. As the thermodynamic potential Ω must be known for the determination of the thermodynamic quantities, the author thoroughly studies the part of the potential connected with the electron gas, proceeding from the formula

$\Omega = -\theta\sum\ln\left[1 + \exp\left(\frac{\zeta-\varepsilon}{\theta}\right)\right]$, where $\theta = kT$, and ζ denotes the chemical potential. For this part he derives a general formula which leads to an equation for the oscillating part ΔN (N - electron number). In the last section, the author calculates ΔN and obtains $\Delta N \sim H^{3/2}$. If there is no logarithmic singularity, one obtains a formula for $\Delta\Omega(\zeta,H,\theta)$, which agrees with that derived by Lifshits and Kosevich. It is noted that the experimentally observable oscillations corresponding to bands "filled to an anomalously low extent" may be due either to separated small surfaces and are then described by the Lifshits-Kosevich theory, or to small convexities or depressions in the main large band, in which case they are described by the present theory. The author thanks I. M. Lifshits for discussions. There are 4 figures and 4 Soviet references.

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24,4500

AUTHOR: Azbel', M. Ya.

TITLE: The Possibility of Determining the Correlation Function for Fermi Fluids in Metals

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 4(10), pp. 1138 - 1147

TEXT: In the introduction, the author discusses the theory of the Fermi fluid developed by L. D. Landau in 1956, which is of great importance for understanding the properties of fluid He^3 and the electronic properties of metals. The set of equations for the general case of an electron Fermi fluid in an electromagnetic field is reduced to a more convenient form than that usually used. The simplicity of the representation proposed is also valid for an electron gas. It is shown that at high frequencies the fluid properties always exhibit themselves in the same way as does the presence of an electric field normal to the surface of the metal. It is found that the only case in which the Fermi fluid effects become pronounced is during cyclotron resonance at very high frequencies which

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84423

The Possibility of Determining the Correlation Function for Fermi Fluids in Metals S/056/60/039/004/041/048 B006/B056

are much higher than those previously considered. In this case the Fermi fluid leads, in particular, to additional broadening of the resonance curve. The possibility of determining the correlation function in metals in this case is discussed. I. M. Lifshits, L. P. Pitayevskiy, and A. M. Pogorelov are mentioned. There are 7 Soviet references.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences Ukrainskaya SSR)

SUBMITTED: April 9, 1960

Card 2/2

86900

24.7900 (1144, 1160, 1395)

S/056/60/039/005/017/051
B006/B077

AUTHOR: Azbel', M. Ya.

TITLE: Quasiclassical Quantization Near Singular Classical Trajectories

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 5(11), pp. 1276-1285

TEXT: It is stated that in the general case the only essential trajectories in the phase space which are important in the thermodynamics are those which are self-intersecting. Such trajectories necessarily exist if the potential well has several bottoms. In the case of a metal in a magnetic field this corresponds to a non-convex boundary Fermi surface. The equation set for these cases is written and it is shown that near the point of self-intersection the distance between the levels has a part which oscillates in a magnetic field. I. M. Lifshits, A. M. Kosevich, M. I. Kaganov, and G. Ye. Zil'berman are mentioned. There are 8 figures and 7 Soviet references.

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Card 1/2

86900

Quasiclassical Quantization Near Singular Classical Trajectories

S/056/60/039/005/017/051
B006/B077

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Institute of Physics and Technology of the Academy of Sciences, Ukrainskaya SSR)

SUBMITTED: May 6, 1960 (initially) and July 11, 1960 (after revision)

Card 2/2

AZBEL', M.Ya.

Combined resonance in metals. Fiz.tver.tela 4 no.2:568-570 F '62. (MIRA 15:2)

(Magnetic fields)

S/056/62/042/002/052/055
B108/B138

AUTHORS: Azbel', M. Ya., Begiashvili, G. A.

TITLE: Width of cyclotron resonance lines in semimetals and determination of correlation function for bismuth

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 2, 1962, 640-641

TEXT: Resonance line width is usually determined by the corresponding relaxation time. In the case of cyclotron resonance however, the line width is considerably dependent on the Fermi liquid interaction. Earlier studies (M. Ya. Azbel'. ZhETF, 39, 1138, 1960) have shown that $\omega\tau_{eff} \sim g$ for $\omega \sim \omega_1$, i.e. for $r \sim \delta_0$ ($\omega_1 \sim v\omega_0/c$, r - Larmor radius of the electrons, $\delta_0 \sim c/\omega_0$, ω_0 - plasma frequency of electrons, v - velocity, $g \sim \int G dS/v$, $G(\vec{p},\vec{p}')$ - correlation function). There is no resonance at $g \sim 1$. The experiments of J. E. Aubrey and R. G. Chambers (J. Phys. Chem. Solids, 3, 128, 1957) with bismuth (where for "holes" $\delta/r \sim 2$, $\omega\tau \sim 370$) showed a resonance width of the order of unity (but not 10^{-2} as might be concluded

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$$\nu_{eff} \sim \frac{1}{\tau_{eff}} \sim \begin{cases} \omega_1 & \text{(quadratic dispersion)} \\ \omega_1(\omega_1/\omega) & \text{(non-quadratic dispersion)} \end{cases}$$

for the range of diamagnetic resonance. It is therefore clear that the relative width of the resonance $1/\omega\tau_{eff}$ which is due to Fermi liquid interaction has a maximum at $\omega \sim \omega_1$. The reason for the Fermi-liquid suppression of resonance not related to any real attenuation and the small value of resonance in nearly all cases is explained without allowing for the fact that interaction itself is by no means small. The point is, that the Fermi liquid interaction leads to an additional spatial dispersion $\omega = \omega(k)$ with respect to a Fermi gas, where as is easy to see, $\omega = k\bar{v}_z + q\Omega$. (It is essential that the distance $\Delta\Omega$ between the levels is independent of k). $\bar{v}_z$ is the mean velocity of the electrons passing into the metals, Ω is the Larmor frequency. k, which occurs in the impedance if the abnormal skin effect is allowed for, leads to suppression of resonance. The "expansion" of resonance, however, is not small only for $kr \sim r/\delta \sim 1$ since the spatial dispersion at normal spin effect is small owing to the inequality $kr \ll 1$. For this reason $\omega(k)$ can be split up. In the abnormal skin effect resonance is possible only in a magnetic field parallel to the surface of the metal, where $\bar{v}_z = 0$ and where ω is finite when $k \to \infty$ so that $\omega(k)$ can be expanded in terms of $1/kr$. I. M. Lifshits is thanked for discussions. [Abstracter's note: Complete translation.] There are 2 references: 1 Soviet and 1 non-Soviet.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physicotechnical Institute of the Academy of Sciences of the Ukrainskaya SSR). Institut kibernetiki Akademii nauk Gruzinskoy SSR (Institute of Cybernetics of the Academy of Sciences of the Gruzinskaya SSR)

SUBMITTED: December 13, 1961

38869

24700

S/056/62/042/006/034/047
B104/B108

AUTHORS: Azbel'. M. Ya., Gurzhi, R. N.

TITLE: Electroconductivity of thin specimens, and the possibilities of determining the free path of electrons in metals

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 6, 1962, 1632 - 1635

TEXT: The electron-phonon collision frequency in thin metal plates can be much greater than in massive metal. Since the temperature dependence of the electric resistance of thin metal plates is mainly determined by the electron-phonon collision, it is smoother than would correspond to Fuchs' formula. Further, the electric resistance of thin metal plates is temperature-dependent down to lower temperatures than that of massive metal. The residual resistance of a thin plate is not attained at $l^{\infty}_{ep} \sim l_{ei}$ as is the case with massive metal, but only at $l^{\infty}_{ep}(T/\Theta)^2 \sim l_{ei}$. l^{∞}_{ep} is the free path of electrons in electron-phonon collisions, l_{ei} is the effective free path in electron-impurity collisions. The possibility of determining

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S/056/62/042/006/034/047
B104/B108

experimentally the free path of electrons from the temperature dependence of the electric resistance is pointed out. There is 1 figure.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk USSR (Physico-technical Institute of the Academy of Sciences UkrSSR)

SUBMITTED: January 21, 1962

41138
S/056/62/043/004/044/061
B125/B186

24.7700

AUTHORS: Lifshits, I. M., Azbel', M. Ya., Slutskin, A. A.

TITLE: The theory of quantum cyclotron resonance in metals

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 43, no. 4(10), 1962, 1464-1478

TEXT: A theory of quantum cyclotron resonance in metals is constructed. The total current density is $\vec{j} = \vec{j}_1 + \vec{j}_2$. $\vec{j}_1$ is caused by the electrons colliding with the surface, $\vec{j}_2$ by the non-colliding electrons. The difference between the quantum and classical formulas of the first order with respect to $\hbar\omega/\zeta$. The quantum expression

$$j_2 = \frac{2e^3 H_0}{h^2 c} \sum_{n,\, l} \int_{-\infty}^{\infty} dp_z \frac{f_0(\varepsilon_{n+l,\, p_z}) - f_0(\varepsilon_{n,\, p_z})}{\varepsilon_{n+l,\, p_z} - \varepsilon_{n,\, p_z}} \frac{A_l(y,\, p_z)}{T^2(-i\omega + il\Omega + 1/\tau)}, \quad (2.4)$$

$$A_l(y,\, p_z) = \int_0^T dt\, v(t)\, u(y - r(t) - r_0)\, e^{-il\Omega t} \int_0^T dt' e^{il\Omega t'} v(t')\, E\left(y - \int_{t'}^{t} v_y dt''\right);$$

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The theory of quantum cyclotron ...

for j_2 gives

$$j_2 = j_2^{\text{кл}}(y) + \frac{e^2 H_0 \omega A(y, \omega/H_0)}{2i\hbar^3 c\pi^2 (\partial\Omega/\partial p_z)_S}\left(\ln\frac{\sin\pi n_2}{\sin\pi n_1} - \pi i x \,\mathrm{sign}\left(\frac{\partial S}{\partial\Omega}\right)_{\varepsilon=\zeta}\right), \qquad (2.5)$$

$$n_2 = n_1 - x, \qquad n_1 = \frac{cS(\omega/H)}{e\hbar H} - \frac{ic(\partial S/\partial\Omega)_{\varepsilon=\zeta}}{e\hbar H\tau}, \qquad x = \frac{(\partial\Omega/\partial p_z)_S}{(\partial\Omega/\partial p_z)_\varepsilon}.$$

for l = 1. $T = 2\pi/\Omega(\varepsilon, p_z)$, $u(x) = 0$ when $x < 0$ and $u(x) = 1$ when $x > 0$. f_0 denotes the Fermi distribution function, $\vec{v}$ the particle velocity, $r(t)$ the y coordinate of the particle measured from the orbit center, and r_0 half the diameter of the electron orbit in the coordinate space. The expression

$$j_m^{\text{кл}}(k) = \frac{1}{k}\sum_{n=1}^{2} A_{mn}\mathcal{E}_n(k),$$

$$j_m^{\text{кв}}(k) = \frac{\lambda}{k}\sum_{n=1}^{2} B_{mn}\mathcal{E}_n(k), \qquad \lambda = \ln\frac{\sin\pi n_2}{\sin\pi n_1} - \pi i x \,\mathrm{sign}\left(\frac{\partial S}{\partial\Omega}\right)_{\varepsilon=\zeta}, \qquad (2.6)$$

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S/056/62/043/004/044/061
B125/B186

The theory of quantum cyclotron ...

sections. The quantum cyclotron resonance can be more easily observed near the singular cross sections mentioned.

ASSOCIATION: Khar'kovskiy gosudarstvennyy universitet (Khar'kov State University). Fiziko-tekhnicheskiy institut Akademii nauk Ukrainskoy SSR (Physicotechnical Institute of the Academy of Sciences of the Ukrainskaya SSR)

SUBMITTED: April 29, 1962

Card 4/4

AZBEL', M.Ya.; GURZHI, R.N.

Electroconductivity of thin specimens and the feasibility of determining the free paths of electrons in metals. Zhur. eksp. i teor. fiz. 42 no.6:1632-1635 Je '62. (MIRA 15:9)

1. Fiziko-tekhnicheskiy institut AN UkrSSR.
(Electric conductivity)
(Electrons)

AZBEL', M. YA.

M. Ya. Azbel, "The Static Skin-Effect." (Not given because speaker was ill.)

report submitted for the Conference on Solid State Theory, held in Moscow, December 2-12, 1963, sponsored by the Soviet Academy of Sciences.

S/181/63/005/003/009/046
B102/B180

AUTHORS: Gurzhi, R. N., Azbel', M. Ya., and Hao Pai Lin

TITLE: Surface effects in infrared optics

PERIODICAL: Fizika tverdogo tela, v. 5, no. 3, 1963, 759-768

TEXT: The surface impedance of metals in the infrared region has frequently been investigated, and with the most generalization, by L. P. Pitayevskiy. The present authors calculate the contribution to impedance made by electron collisions with the surface, which has not been accurately taken into account. The electron gas is considered as a Fermi fluid with arbitrary anisotropic dispersion law governing the quasiparticles, and the effect of this anisotropy is studied. The skin effect depends mainly on the relation between ω the frequency of the applied field and the characteristic parameters of the conduction electrons (v_0, their velocity at the Fermi surface, their mean free path $l = v_0\tau$) and on δ the thickness of the skin layer; $\delta \sim \delta_0 [1+(\omega\tau)^{-2}]^{1/4}$, $\delta_0^{-2} = 4\pi ne^2/mc^2$. The case $\omega\tau \lesssim 1$ has been fully

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investigated and therefore the authors only consider "high" frequencies $\omega\tau \gg 1$ (or $v_0/\omega\delta \ll 1$). For the infrared range $\omega \gg 1/\tau = \nu$, $\omega \gg v_0/\delta_0 \sim \omega_0 v_0/c$, and with the additional assumptions $\omega_0 \gg \omega \gg \nu$, $k\theta/\hbar$, the limits of the problem can be given by

$$\omega_0 \gg \omega \gg \omega_0 \frac{v_0}{c} \sim \frac{k\theta}{\hbar}, \quad \frac{kT}{\hbar}, \quad \omega_0 c_i, \quad \omega_0\left(\frac{kT}{\hbar\omega_0}\right)^2, \quad \omega_0\left(\frac{\omega}{\omega_0}\right)^2. \tag{7a}$$

The electron-phonon collision frequencies for normal (superscript н.) and abnormal (ан.) skin effect are thus given by

$$\nu^{\text{н.}}_{ef} \sim \begin{cases} \dfrac{kT}{\hbar}, & T \gg \theta, \\ \dfrac{k\theta}{\hbar}\left(\dfrac{T}{\theta}\right)^5, & T \ll \theta. \end{cases} \qquad \nu^{\text{ан.}}_{ef} \sim \frac{k\theta}{\hbar} \begin{cases} \left(\dfrac{T}{\theta}\right)^3, & \hbar\omega \ll kT, \\ \left(\dfrac{\hbar\omega}{k\theta}\right)^3, & \hbar\omega \gg kT. \end{cases}$$

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Surface effects in infrared optics

The electromagnetic properties of the electron gas are defined by $\varepsilon_0' = -\frac{\omega_0^2}{\omega^2}$, $\varepsilon'', \varepsilon_1' \sim |\varepsilon_0'| \frac{\nu}{\omega} \sim \frac{\omega_0^2 \nu}{\omega^3}$, $\varepsilon = \varepsilon' + i\varepsilon''$; $\zeta = \frac{c}{4\pi} Z = \zeta' + i\zeta'' \sim \frac{1}{\sqrt{\varepsilon}}$, $\zeta'' \sim \frac{\omega}{\omega_0}$, $\zeta' \sim \frac{\nu}{\omega_0}$ where ζ is the surface impedance. $\nu = \nu_{ee} + \nu_{ef} + \nu_{ei} + \nu_{eff}^{surf}$; $\nu_{eff}^{surf} \sim v/\delta_0 \sim \omega_0 v/c$. The problem is first considered in neglect of the effects of the Fermi fluid. As usual, the kinetic equation and the Maxwell equations have to be solved jointly. The results are

$$\left. \begin{aligned} (\hat{Z}^{-1}_{\text{non.}})_{\alpha\beta} = \frac{\tau_i v_0}{4\pi} \Bigg\{ Q_{\alpha\beta} - \frac{K_{\alpha z}(0) Q_{\beta z} + K_{\beta z}(0) Q_{\alpha z}}{K_{zz}(0)} + \frac{K_{\alpha z}(0) K_{\beta z}(0) Q_{zz}}{K^2_{zz}(0)} + \\ + \int_0^\infty \int_0^\infty L_{zz}(|\zeta - \zeta'|) \chi_\alpha(\zeta) \chi_\beta(\zeta') \, d\zeta d\zeta' \Bigg\} \equiv \frac{3}{16} \cdot \frac{c}{4\pi} \frac{v_0}{c} \left(\frac{\omega_0}{\omega}\right)^2 m_{\alpha\beta}; \\ Q_{\mu\nu} = \frac{3}{4\pi p_0^2 v_0^3} \int_{v_z > 0} \frac{dS}{v} v_\mu v_\nu v_z. \end{aligned} \right\} \tag{14}$$

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S/181/63/005/003/009/046
B102/B180

Surface effects in infrared optics

for a cubic lattice

$$\zeta_{\alpha\beta} = \frac{c}{4\pi} Z_{\alpha\beta} = i\delta_{\alpha\beta}\frac{\omega}{\omega^0} + \frac{3}{16}\left(\frac{\omega_0}{\omega^0}\right)^2 \frac{v_\zeta}{c} \cdot m_{\alpha\beta}, \tag{15}$$

where

$$\left.\begin{array}{l} L_{\mu\nu}(\zeta) = \frac{3}{4\pi p_0^2} \int\limits_{v_z>0} \frac{ds}{v} \frac{v_\mu v_\nu}{v_z} e^{-\gamma\zeta}; \quad \mu, \nu = x, y, z; \\ \eta = \frac{4\pi n e^2}{m\omega^2} = \frac{\omega_0^2}{\omega^2}; \quad n = \frac{8\pi}{3}\left(\frac{p_0}{h}\right)^3; \quad m_0 = \frac{p_0}{v_0}. \end{array}\right\} \tag{12b}$$

$$K_{\mu\nu}(\zeta) = \frac{3}{4\pi p_0^2 v_0} \int\limits_{v_z>0} \frac{dS}{v} v_\mu v_\nu e^{-\gamma\zeta}, \tag{13a}$$

$\gamma = iv_0/v_z$. Allowing for the Fermi fluid effects (14) and (15) remain

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Surface effects in infrared optics

valid if

$$L_{\mu\nu}(\zeta)=\frac{3}{4\pi p_0^2}\oint\limits_{v_z>0}\frac{dS}{v}v_\mu\exp(-\zeta\hat{\gamma})\frac{v_\nu}{v_z},\qquad \hat{\Phi}\psi(\mathbf{p})=\oint\frac{dS'}{v'}\Phi(\mathbf{p},\mathbf{p}')\psi(\mathbf{p}'),$$

$$K_{\mu\nu}(\zeta)=\frac{3}{4\pi p_0^2 v_0}\oint\limits_{v_z>0}\frac{dS}{v}v_\mu\exp(-\zeta\hat{\gamma})(1+\hat{\Phi})v_\nu,$$

$$\hat{\gamma}=i\frac{v_n}{v_z}(1+\hat{\Phi})^{-1}$$

$$Q_{\mu\nu}=\frac{2}{4\pi p_0^2 v_0^2}\oint\limits_{v_z>0}\frac{dS}{v}v_\mu(1+\hat{\Phi})v_z(1+\hat{\Phi})v_\nu.$$

ASSOCIATION: Fiziko-tekhnicheskiy institut AN USSR, Khar'kov (Physicotechnical Institute AS UkrSSR, Khar'kov)

SUBMITTED: September 27, 1962

Card 5/5

L 17630-63 EWT(1)/EWP(q)/EWT(m)/ S/056/63/044/003/031/053
BDS/ES(w)-2 AFFTC/ASD/IJP(C)/SSD Pab-4 JD

63

AUTHOR: Azbel', M. Ya.

TITLE: Quantization of quasi-particles with a periodic dispersion law in a strong magnetic field 21

PERIODICAL: Zhurnal eksperimental'noy i tekhnicheskoy fiziki, v. 44, no. 3, 1963, 980-982

TEXT: The author investigated the changes in the structure of the well known energy levels (Ref. 1: I. M. Lifshits and M. I. Kaganov, UFN, 69, 419, 1959) of charged particles with an arbitrary dispersion law in a weak magnetic field (under quasi-classical conditions), due to the increase in magnitude of the magnetic field (when the quasi-classical condition is no more applicable and the essential periodicity in the dispersion law starts). The character of the spectrum of a charged quasi-particle in a crystal lattice in a very strong magnetic field H is ascertained for the simplest case when one can neglect transitions between the zones. It is shown that the energy levels and wave functions are periodic functions of H.

SUBMITTED: October 8, 1962

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L 17629-63 EWT(l)/EWG(k)/EWP(q)/ S/056/63/044/003/032/053
EWT(m)/BDS/EEC(b)-2/ES(w)-2 AFFTC/ASD/ESD-3/IJP(C)/SSD Pz-4/Pab-4 AT/JD 76
75

AUTHOR: Azbel', M. Ya.

21

TITLE: Static skin effect for currents in a strong magnetic field and the resistance of metals 18 21

PERIODICAL: Zhurnal eksperimental'noy i tekhnicheskoy fiziki, v. 44, no. 3, 1963, 983-998

TEXT: The author starts with the description of the "static skin effect" which differs from the ordinary skin effect by the fact that the inside current is small but does not tend to zero and that the projection of the electric field in the direction of the total current is homogeneous over the entire depth. The present paper is within the framework of the classical theory of galvanomagnetic effects in thick samples with closed electron trajectories. It is shown that in a strong magnetic field $\vec{H}$ ($r \ll 1$, r is the Larmor radius, l - the electron mean free path) the magnitude of a direct current in a sample with a sufficiently good surface (whose distortions are small compared to r) drops rapidly in the direction from the surface towards the center of the sample (static skin effect). In very strong magnetic fields (such that $r \ll l(l/d)^2$ for equal numbers of electrons n_1 and

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L 17629-63 S/056/63/044/003/032/053

Static skin effect...

"holes" n_2 or $r \ll l(l/d)$ for $n_1 \neq n_2$, where d is the sample thickness) the total current flows mainly near the surface in a layer with a thickness l if the field is parallel to the surface. For $n_1 = n_2$ and a polygonal cross section, the current flows near the vertexes at distances of the order of l from them. This type of current distribution leads to a linear dependence of the resistance on the magnetic field even for single crystals with closed Fermi surfaces (the conditions for observing this dependence and its origin are completely different from those for the linear Kapitza law which holds for polycrystals with open Fermi surfaces). The particular results depend significantly on the conductor configuration and the orientation of the magnetic field. The directions of sharp anisotropy of the $\rho(H)$ dependence are determined, and it is shown that the transformation of a "good" surface into a "bad" one results in a sharp increase of the resistance $\rho \sim H^2$ for $n_1 = n_2$ and to a sharp drop in resistance $\rho \rightarrow$ const for $n_1 \neq n_2$ within the given magnetic field. Since the type of statistics is irrelevant for the derivations in the article, the results of the paper are applicable also for semiconductors. There are 5 figures.

SUBMITTED: October 10, 1962

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S/056/63/044/004/021/044
B102/B106

AUTHOR: Azbel', M. Ya.

TITLE: Resistance of thin plates and wires in a magnetic field

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 44, no. 4, 1963, 1262 - 1270

TEXT: The resistance of plates and wires of thickness d placed in a uniform magnetic field H is calculated as a function of the field strength. The diameters are always assumed to be much smaller than the electron mean free path: $d \ll l$. $\varrho(H)$ is separately calculated for strong ($r \ll d$) and weak fields ($r \gg d$) directed parallel or at an inclination to the plate or the wire; r is the orbital Larmor radius. Since the cases $n_1 = n_2$ and $n_1 \neq n_2$ are also treated separately, there is a great number of possible combinations, i.e. of $\varrho(H)$ functions. The most important results are shown in the figures. The main features of the curves are: rapid drop of ϱ of plates in fields $r \sim l^2/d$; linear $\varrho(H)$ in strong fields, inflection at $2r_{max} \approx d$ in the plate; slow variation for $\vec{H} \parallel \vec{J}$: ϱ increases to the $\ln(l/d)$-fold when H increases

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Resistance of thin plates and wires... S/056/63/044/004/021/044
B102/B186

to the $(1/d)^2$-fold (curve $A_2+B_2/\ln(H_0/H)$); decrease of ϱ (factor $1/d$) when H increases (curve A_3-B_3H). There are 6 figures.

SUBMITTED: October 8, 1962

Fig. 3. $\varrho(H)$ for a wire in an inclined field.

Fig. 4. $\varrho(H)$ for a wire in a parallel field.

Fig. 5. $\varrho(H)$ for a plate in an inclined field. Branch I: $n_1=n_2$, $\vec{H}$ not in the $\vec{\xi}\vec{v}$-plane or $\vec{H}\nparallel\vec{\xi}$; Branch II: $n_1=n_2$, $\vec{H}$ in the $\vec{\xi}\vec{v}$-plane but $\vec{H}\nparallel\vec{\xi}$ or $n_1\neq n_2$, and $\vec{H}$ not in the $\vec{\xi}\vec{v}$-plane; Branch III: $n_1\neq n_2$, $\vec{H}$ in the $\vec{\xi}\vec{v}$-plane; Branch IV: A_5H^2; $n_1=n_2$; Branch V: $n_1\neq n_2$.

Fig. 6. $\varrho(H)$ for a plate in a parallel field. Branch I: $\vec{H}\nparallel\vec{v}$; Branch II: $\vec{H}\parallel\vec{v}$; Branch III: $n_1=n_2$, $\vec{H}\nparallel\vec{v}$; Branch IV: $n_1\neq n_2$ or $n_1=n_2$ and $\vec{H}\parallel\vec{v}$. $\vec{\xi}$ is normal to the surface. In all cases $\vec{J}\parallel\vec{v}$.

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Fig. 3

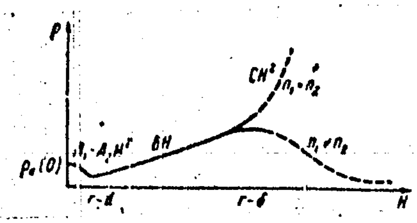


Fig. 4

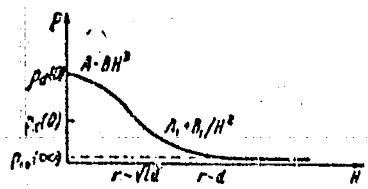


Fig. 5

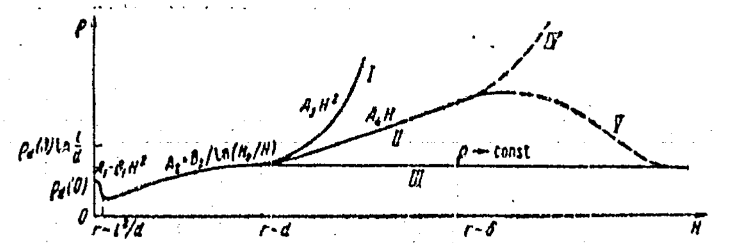
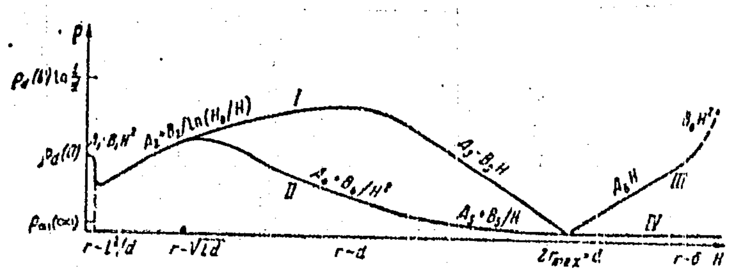


Fig. 6



L 17221-63 EPR/EWT(d)/EPF(c)/EWT(l)/EPF(n)-2/EWP(q)/EWT(m)/BDS/ES(t)-2
AFFTC/ASD/IJP(C)/SSD Ps-4/Pr-4/Pu-4 JD

ACCESSION NR: AP3005306 S/0056/63/045/002/0396/0397

79
78

AUTHOR: Azbel', M. Ya.

[redacted]

TITLE: Attainment of low temperatures with the aid of the de Haas-van Alphen effect

SOURCE: Zhur. eksper. i teoret. fiz., v. 45, no. 2, 1963, 396-397

TOPIC TAGS: adiabatic demagnetization, de Haas effect, low temperature in metal, low temperature, metal

ABSTRACT: It is demonstrated with the aid of a formula derived by Lifshits and Kosevich (ZhETF v. 29, 730, 1955) that adiabatic variation of the magnetic field in metals leads to a decrease in temperature, in analogy with the result of adiabatic demagnetization of paramagnetic salts. The required change in the magnetic field is from the value at which the oscillating part of the magnetic moment

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L 17221-63
ACCESSION NR: AP3005306

is minimal to that at which it is maximal (i.e., by half the period of the de Haas--van Alphen oscillations). Under certain conditions a ratio $\Delta T/T$ from 1 to 10% can be obtained. Orig. article has 5 formulas.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physics Problems, Academy of Sciences, SSSR)

SUBMITTED: 12June63 DATE ACQ: 06Sep63 ENCL: 00

SUB CODE: PH NO REF SOV: 003 OTHER: 000

Card 2/2

ACCESSION NR: AP4009128 S/0056/63/045/006/2022/2023

AUTHOR: Azbel', M. Ya.

TITLE: Quantum oscillations at high temperatures

SOURCE: Zhurnal eksper. i teoret. fiziki, v. 45, no. 6, 1963, 2022-2023

TOPIC TAGS: Fermi surface, quantum oscillation, self intersecting trajectories, Landau level, single parameter trajectory family, high temperature, deHaas vanAlphen effect, Shubnikov deHaas effect

ABSTRACT: Using calculations similar to those in an earlier paper (ZhETF v. 39, 878, 1960), the author shows that fairly large quantum oscillations exist on the single-parameter family of self-crossing sections of the Fermi surface at temperatures that are high compared with the distance between the Landau levels, viz. ~30K for the principal bands and 100K for anomalously small bands. Hypothetically

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these trajectories can be detected by noting the sharp increase in the amplitude of the oscillations as the magnetic field is rotated. Orig. art. has: 1 figure and 4 formulas.

ASSOCIATION: Institut teoreticheskoy i eksperimental'noy fiziki (Institute of Theoretical and Experimental Physics)

SUBMITTED: 12Jun63 DATE ACQ: 02Feb64 ENCL: 00

SUB CODE: PH NO REF SOV: 005 OTHER: 000

Card 2/2

ACCESSION NR: AP4019235 S/0056/64/046/002/0673/0676

AUTHOR: Azbel', M. Ya.; Voronel' A. V.; Giterman, M. Sh.

TITLE: Contribution to the theory of the critical point

SOURCE: Zhurnal eksper. i teor. fiz., v. 46, no. 2, 1964, 673-676

TOPIC TAGS: critical point, free energy, equation of state, coexistence curve, phase equilibrium, free energy, specific heat, singularity, critical volume

ABSTRACT: In view of the discrepancy with ordinary theory displayed by the experimental results of the VNIIFTRI Thermodynamics Laboratory (M. I. Bagatskiy, A. V. Voronel', V. G. Gusak, ZhETF, v. 43, 728, 1962; A. V. Voronel', Yu. R. Chashkin, V. A. Popov, V. G. Simkin, ZhETF, 45, 828, 1963), where a logarithmic singularity was observed for the temperature dependence of the specific heat C_v near the critical volume, the authors propose a new theory in which the form of the free energy near the critical point agrees with these experimental data. In both the existing and modified theories the order of the smallest nonvanishing derivative of the pressure with respect to the volume at the critical point determines

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uniquely the form of the phase-equilibrium point near the critical point, namely proportionality of the relative temperature to the relative volume quared. Several ways of chedking the consequences due to the presence of the singularity at the critical point will be treated in a future article. Orig. art. has: 6 formulas.

ASSOCIATION: Institut fiziko-tekhnicheskikh i radiotekhnicheskikh izmereniy (Institute of Physicotechnical and Radio Technical Measurements)

SUBMITTED: 12Jul63 DATE ACQ: 27Mar64 ENCL: 00

SUB CODE: PH NO REF SOV: 004 OTHER: 001

Card 2/2

AZBEL', M. Ya.

Energy spectrum of conductivity electrons in a magnetic field. Zhur.eksp. i teor.fiz. 46 no. 3:929-946 Mr '64. (MIRA 17:5)

1. Institut fizicheskikh problem AN SSSR.

L 16515-65 EWT(1)/EPF(c)/EPA(w)-2 Pab-10/Pr-4 IJP(c)/ESD(t)/SSD/AFWL/ AS(mp)-2 WW

ACCESSION NR: AP5000356 S/0056/64/047/005/1958/1965

AUTHORS: Azbel', M. Ya.; Skrotskaya, Ye. G. B

TITLE: Magnetic susceptibility in strong magnetic fields

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 47, no. 5, 1964, 1958-1965

TOPIC TAGS: magnetic susceptibility, conduction electron, temperature dependence, dispersion law, magnetic moment

ABSTRACT: In connection with the difficulties encountered in the past in separating the monotonic susceptibility of the conduction electrons from the lattice susceptibility, the authors calculate the dependence of the susceptibility on the temperature and on the magnetic field by first determining the magnetic moment of the conduction electrons in strong fields. An expression is then obtained for the susceptibility in explicit form and a criterion is derived

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for magnetic fields which can be regarded as strong for this calculation. Calculations are made for both quadratic (but anisotropic) and arbitrary dispersion laws, and it is shown that for the latter case an experimental investigation of the magnetic susceptibility will yield the field dependence of the energy and of the state denwity at the ground state; in the case of a quadratic dispersion law in strong magnetic fields, the total magnetic moment (diamagnetic and paramagnetic) tends to saturation. The monotonic part of the susceptibility is obtained by subtracting the oscillating part (the deHaas--VanAlphen effect). It is concluded that in strong magnetic fields the magnetic moment in the main approximation does not depend on the temperature and is determined only by the magnetic-field-dependence of the ground state energy. In extremely strong magnetic fields, the magnetic moment is subject to a small increment that depends linearly on the temperature; the proportionality coefficient is determined by the density of states at the ground state. Orig. art. has: 22 formulas.

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ACCESSION NR: AP5000356

ASSOCIATION: Institut Fiziko-tekhnicheskikh i radiotekhnicheskikh izmereniy (Institute of Physicotechnical and Radio Measurements)

SUBMITTED: 26May64

ENCL: 00

SUB CODE: EM

NR REF SOV: 010

OTHER: 000

Card 3/3

AZBEL', M. Ya.

Spectrum of difference equations with periodic coefficients. Dokl. AN SSSR 159 no.4:703-706 D '64 (MIRA 18:1)

1. Predstavleno akademikom I.G. Petrovskim.

L 52968-65 EWT(1)/EPA(s)-2/EWT(m)/EWP(w)/EWA(d)/EEC(t)/T/EWP(t)/EWP(b)
Pt-7/Pl-4 IJP(c) JD/GG

ACCESSION NR: AP5010524 UR/0056/65/048/004/1206/1209

AUTHOR: Azbel', M. Ya.; Brandt, N. B.

TITLE: Transformation of a metal into a dielectric and singularities of electronic characteristics of metals in strong magnetic fields

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 48, no. 4, 1965, 1206-1209

TOPIC TAGS: carrier density, metal dielectric transformation, magnetic field effect, thermodynamic potential, chemical potential

ABSTRACT: The authors calculate the shift in the boundaries of the energy bands in a metal, necessary for this metal to turn into a dielectric. The feasibility of such a shift with the aid of a constant magnetic field is illustrated using as an example electrons with a quadratic dispersion law. For anomalously minimal bands and for metals of the bismuth type, the required field is of the order of 10^5--10^6 Oe. The dependence of various electronic characteristics on the magnetic field is analyzed. This includes the conductivity and the thermodynamic and chemical potentials. It is shown that at the value of the field at which the edges of the bands come in contact, the thermodynamic potentials and their derivatives remain constant

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ACCESSION NR: AP5010524

(except for the derivatives with respect to the magnetic field). The magnetic moment has the same singularities and the same character of dependence on the magnetic field as the conductivity. At 0°K the magnetic susceptibility experiences an infinite jump at $H = H_k$. Similar singularities result when the chemical potential assumes values of the energy that are singular for the given band (at which a new equal-energy surface appears, at which a transition takes place from the open surfaces to the closed ones and vice-versa, etc.). It is shown also that variation of the chemical potential in the magnetic field can be used to investigate the dispersion law and its singularities over a wide range of energies. Orig. art. has: 2 figures and 3 formulas.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: 23Jan65 ENCL: 00 SUB CODE: SS

NR REF SOV: 009 OTHER: 002

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L 5353-66 EWT(1)/EWT(m)/EPF(c)/EPA(w)-2/EWP(t)/EWT(b)/EWA(h) IJP(c)
ACCESSION NR: AP5021121 JD/WW UR/0056/65/049/002/0572/0587

AUTHOR: Azbel', M. Ya.; Peschanskiy, V. G.

TITLE: Resistance of thin plates and wires in a strong magnetic field

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 49, no. 2, 1965, 572-587

TOPIC TAGS: electric resistance, magnetoresistance, carrier density, distribution function, skin effect

ABSTRACT: The authors present, for the first time in a literature, a method for the exact determination of the resistance of a thin wire and for finding the distribution of the current and the field in a wire of arbitrary shape in a strong magnetic field, for any arrangement and shape of the contacts. The mean free path of the conduction electrons is assumed to be infinite. For a plane parallel plate, an exact solution of the same problem is given without making any assumptions about the magnitude of the magnetic field. The approach is

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based on a precise fomulation of the complete system of equations, which are essentially different in the microscopic and phenomenological theories, and of the boundary conditions for the distribution function of the conduction electrons. It is shown in particular that the distribution function of the electrons reflected at the surface is not the equilibrium Fermi function, as is usually assumed. It is also shown that the resistance is very sensitive to the nature of the contacts and become infinite in the case of point contacts. At the same time, the ratio of the potential difference near the contact to the current strength is stable and independent of the type of contacts. As the shape and size of the contacts are varied, the dependence of the resistance on the strong magnetic field changes from saturation to quadratic growth. A static skin effect occurs in a strong magnetic field, with the entire current localized in a layer whose thickness is of the order of the Larmor radius. If the contact arrangement is symmetrical, the static skin effect appears only in conductors with an equal number of holes and electrons, and does not affect the dependence of the resistance on the magnetic field. Orig. art. has: 6 figures and 57 formulas.

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ACCESSION NR: AP5021121

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ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University); Fiziko-tekhnicheskiy institut nizkikh temperatur Akademii nauk Ukrainskoy SSR (Physicotechnical Institute of Low Temperatures, Academy of Sciences, UkrSSR)

SUBMITTED: 22Feb65 ENCL: 00 SUB CODE: EM

NR REF SOV: 005 OTHER: 003

Card 3/3

ACC NR: AP6010434 SOURCE CODE: UR/0386/66/003/005/0201/0205

AUTHOR: Azbel', M. Ya.; Begiashvili, G. A.

ORG: Institute of Cybernetics, Academy of Sciences, Georgian SSR (Institut kibernetiki Akademii nauk Gruzinskoy SSR)

TITLE: Contribution to the theory of quantum oscillations of surface impedance

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki. Pis'ma v redaktsiyu. Prilozheniye, v. 3, no. 5, 1966, 201-205

TOPIC TAGS: quantum oscillation, surface property, electric impedance, diamagnetism, conduction electron, magnetic moment, kinetic equation

ABSTRACT: The article deals with the quantum oscillations of both the thermodynamic and kinetic quantities which are due to diamagnetic Landau-level quantization of the electron energies at temperatures that are low compared with the Fermi degeneracy temperature, and which can be quite large in sufficiently strong magnetic fields. At alternating electromagnetic fields and in a quantizing constant magnetic field these reduced to a single quantity, the total surface impedance. The authors estimate the contributions made to these oscillations by the nonrelativistic oscillations of the conduction current and by the relativistic oscillations of the magnetic moment, which are essentially of a different order of magnitude. It is shown that at low frequencies the surface-impedance oscillations are determined essentially by the de Haas--van Alphen effect, and the relative amplitude of the impedance oscillations

ACC NR: AP6010434

is proportional to $\chi^{-1/2}$ (χ -- magnetic susceptibility). With increasing frequency, the relative role of the oscillations of the magnetic moment decreases, and the surface-impedance oscillations are determined by the Shubnikov--de Haas effect. It is indicated that to construct a consistent theory for the general case it is necessary to combine Maxwell's equations with ordinary boundary conditions and to solve in addition a kinetic equation for the density matrix, for which different approximations must be made at low and high frequencies. The derivation of the exact formulas and comparison with experiment will be reported separately. Orig. art. has: 1 formula.

SUB CODE: 20/ SUBM DATE: 09Jan66/ ORIG REF: 007/ OTH REF: 001

Card 2/2 UVR

ACC NR: AP7003538 SOURCE CODE: UR/0386/67/005/001/0026/0029

AUTHOR: Azbel', M. Ya.; Peschanskiy, V. G.

ORG: Institute of Theoretical Physics, Academy of Sciences SSSR (Institut teoreticheskoy fiziki Akademii nauk SSSR)

TITLE: Cyclotron resonance in an inclined magnetic field

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki. Pis'ma v redaktsiyu. Prilozheniye, v. 5, no. 1, 1967, 26-29

TOPIC TAGS: cyclotron resonance, conduction electron, galvanomagnetic effect, electron motion

ABSTRACT: Unlike earlier papers, which were confined to cyclotron resonance in a constant magnetic field H inclined at a small angle φ to the surface of the metal, the authors discuss the theory of resonance at arbitrary φ, when there is no resonance in the principal approximation in terms of the anomaly. It is shown that in the next higher approximation in the anomaly, a new type of resonance and of periodic oscillations appears also in a parallel field ($\varphi = 0$), owing to the field and current peaks (similar to those considered by one of the authors earlier (ZhETF v. 39, 400, 1960) at depths that are multiples of the orbit diameters D. In a parallel field the resonance occurs at frequencies Ω corresponding to the limiting points and the central section of the Fermi surface to the extremal values of the effective mass m, and (owing to the peaks) to the extremal orbit diameters. When the magnetic field is in-

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ACC NR: AP7003538

clined, the first to disappear is the resonance on the extremal "noncentral" sections, owing to the electron drift. With increasing inclination of H, the decisive role is assumed by the field peaks which "pick out" a narrow group of electrons. This alters substantially the shape of the resonance curve, whereas the resonance frequency Ω_c remain constant. Eventually, all that remains is the resonance due to the "new" peaks from the drifting electrons. The variation of the resonance at the limiting point with changing φ is described. Experimental investigations of this resonance would make it possible to determine the effective mass and the area of the Fermi-surface section, and would permit a comparison of the same Fermi-surface characteristics obtained from different experiments. The accuracy of the agreement between them may be evidence of the degree of accuracy obtained by introducing quasiparticles (conduction electrons) in the metal. The authors thank V. F. Gantmakher, M. S. Khaykin, and R. T. Mina for a useful discussion.

SUB CODE: 20/ SUBM DATE: 26Oct66/ ORIG REF: 008/ OTH REF: 005

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